

# IQANdesign CAN

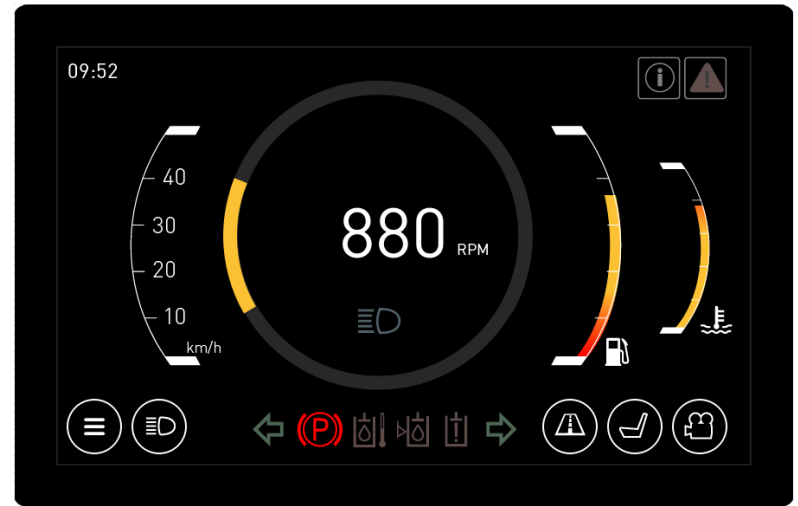
**SAE J1939**



Presented by

# SAE J1939 CAN bus protocol

- CAN protocol for
  - Engines
  - Transmissions
  - ...



# SAE J1939 standard



- **SAE J1939** was designed to allow electronic devices from different vendors to communicate with each other through a standard architecture

# J1939 in OSI Reference Model

- J1939/11 - Physical Layer - twisted pair, twisted quad, ...
- **J1939/21 - Data Link Layer - define frame**
  - (Protocol Data Unit (PDU))
  - format, point-to-point and broadcast (BLAST) protocols
- J1939/31 - Network Layer
- **J1939/71 - Application Layer**
- J1939/81 - Network Management
- J1939/0\* - General documentation:
  - 01 - Truck and Bus
  - 02 - Agricultural Equipment
  - ...

# PGN 61444

## Electronic Engine Controller 1

## EEC1

Transmission repetition rate: engine speed dependent  
Data length: 8 bytes  
Data page: 0  
PDU format: 240  
PDU specific: 4  
Default priority: 3  
Parameter group number: 61 444 (00F004<sub>16</sub>)

Start	Length	Parameter Name	SPN
1.1	4 bits	Engine Torque Mode	899
1.5	4 bits	Actual Engine - Percent Torque High Resolution	4154
2	1 byte	Driver's Demand Engine - Percent Torque	512
3	1 byte	Actual Engine - Percent Torque	513
4-5	2 byte	Engine Speed	190
6	1 byte	Source Address of Controlling Device	1483
7.1	4 bits	Engine Starter Mode	1675
8	1 byte	Engine Demand – Percent Torque	

# SPN 190

# Engine Speed

Engine Speed / Actual engine speed which is calculated over a minimum crankshaft angle of 720 degrees divided by the number of cylinders.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit gain, 0 rpm offset
Data Range:	0 to 8031.875 rpm
Type:	Measured
Supporting information:	
PGN reference:	61444

# SPN 513 Actual Engine - Percent Torque

The calculated output torque of the engine.

Data Length:	1 byte
Resolution:	1 %/bit, -125 % offset
Data Range:	-125 to 125 % Operational Range: 0 to 125%
Type:	Measured
Supporting Information:	
PGN reference:	61444

# PGN 65262

## Engine temperature

ET1

Transmission repetition rate: 1 s  
Data length: 8 bytes  
Data page: 0  
PDU format: 254  
PDU specific: 238  
Default priority: 6  
Parameter group number: 65 262 (00FEEE<sub>16</sub>)

Start	Length	Parameter Name	SPN
1	1 byte	Engine coolant temperature	110
2	1 byte	Fuel temperature	174
3	2 bytes	Engine oil temperature1	175
5	2 bytes	Turbo oil temperature	176
7	1 byte	Engine intercooler temperature	52
8	1 byte	Engine intercooler thermostat opening	1134



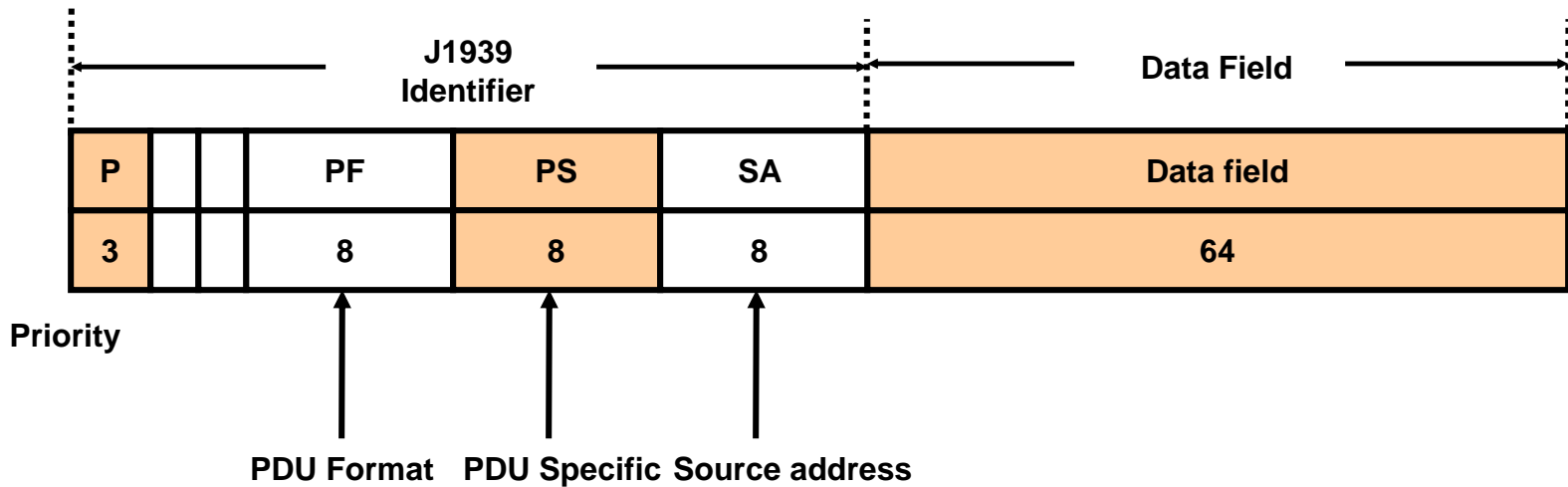
# SPN 110 Engine Coolant Temperature

Temperature of liquid found in engine cooling system.

Data Length:	1 byte
Resolution:	1 °C/bit gain, -40 °C offset
Data Range:	-40 to +210 °C (-40 to 410 °F)
Type:	Measured
Suspect Parameter Number:	110
PGN Reference:	65262

# J1939 CAN frame

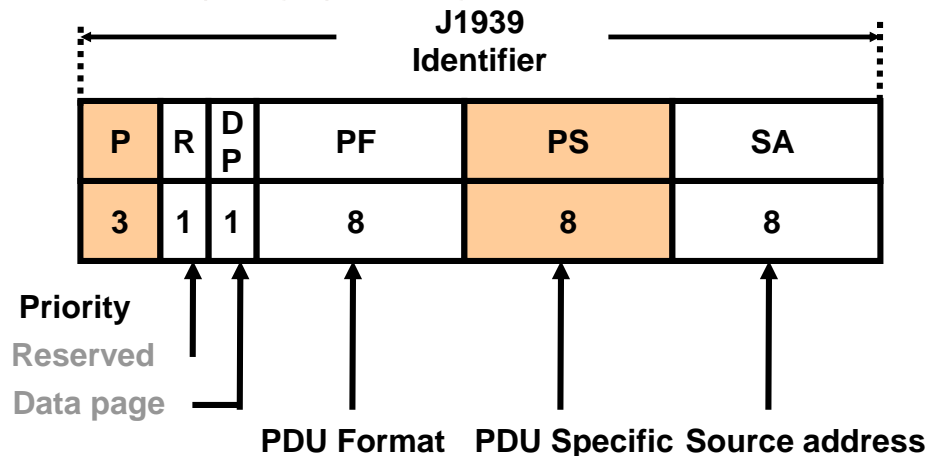
- Identifier (29 bit)
- Data field (up to 64 bit)



# J1939 Identifier

- **29-bit identifier**

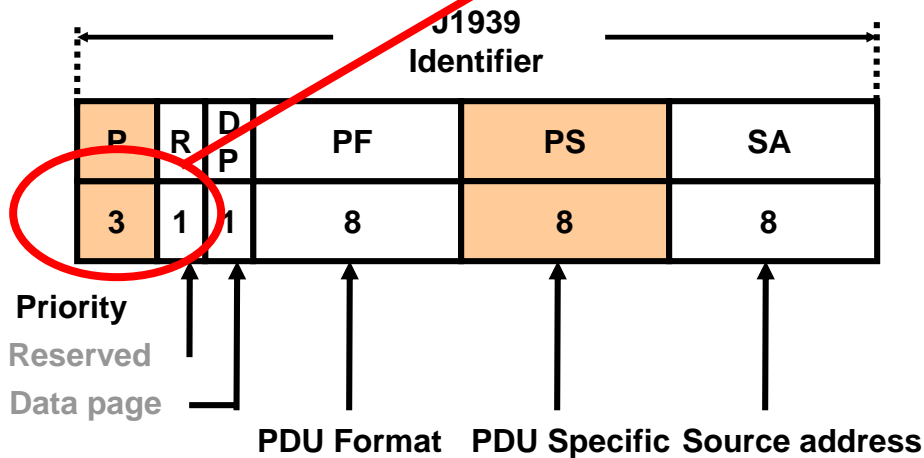
- Priority (3 bits)
- *Reserved Bit (1 bit)*
- *Data Page (1 bit)*
- PDU (Protocol Data Unit) Format (PF) (8 bits)
- PDU (Protocol Data Unit) Specific (PS) (8 bits)
- Source Address (SA) (8 bits)



# Priority

- **Priority:**

- 3 bits (0 - 7)
- 0 is highest
- recommended: Don't care



Property Inspector - J1939 frame input channel (JFIN)

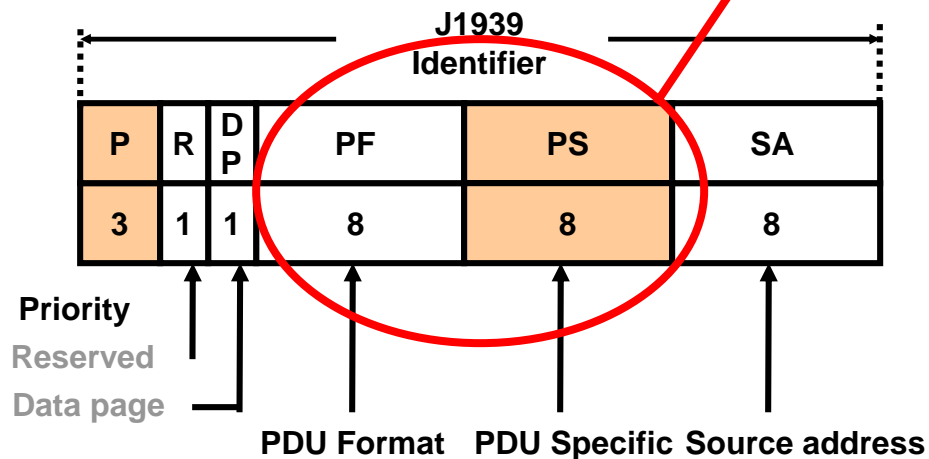
Property	Value
c>Name	EEC #1
Description	
Priority	Don't care
PGN	6144
Destination address (DA)	
Timeout [ms]	50
Poll trigger	Not used
⊕ Paged protocol	{Not used}
⊖ Parameters	{{Engine speed [rpm]; 25}}
⊖ Parameter 1	{Engine speed [rpm]; 25}
Channel	Engine speed [rpm] - J1939 parameter
Bit offset [bits]	25

# J1939 Identifier - PGN

- Parameter Group Number
  - 2 bytes

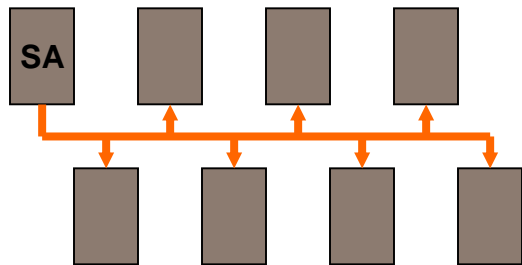
Property Inspector - J1939 frame input channel (JFIN)

Property	Value
Name	EEC #1
Description	
Priority	Don't care
<b>PGN</b>	<b>51444</b>
Destination address (DA)	
Timeout [ms]	50
Poll trigger	Not used
⊕ Paged protocol	{Not used}
⊖ Parameters	{{Engine speed [rpm]; 25}}
⊖ Parameter 1	{Engine speed [rpm]; 25}
Channel	Engine speed [rpm] - J1939 parameter
Bit offset [bits]	25



# PGN Type B (PDU 2)

- Broadcast
- PS is *Group Extension*
- $PGN = PF * 256 + PS$



SAE standard, broadcast

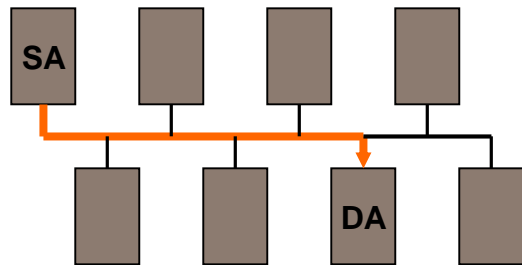
Name:	PF	PS (GE)	PGN
ERC 1	240	0	61440
EBC 1	240	1	61 441
.....			
WFI	254	255	65 279

Manufacturer assigned, broadcast

Name:	PF	PS (GE)	PGN
xx	255	0	65 280
.....			
xx	255	255	65 535

# PGN Type A (PDU 1)

- Addressed
- PS is *Destination Address*
- $PGN = PF * 256$



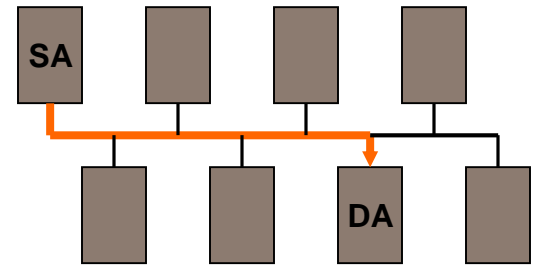
SAE standard, destination address

Name:	PF	PS (DA)	PGN
TSC #1	0	0 - 255	0
TC #1	1	0 - 255	256
.....			
N/A	238	0 - 255	60 928

Manufacturer assigned,  
destination address  
(Proprietary A)

Name:	PF	PS (DA)	PGN
xx	239	0 - 255	61 184

# JFIN PDU1 message



- Destination Address  
=Addressed to me  
IQAN master address *or*  
255 (broadcast)

Property Inspector - J1939 frame input channel (JFIN)

Property	Value
<> Name	Aux I/O status 5
Description	
Priority	Don't care
PGN	2048
Destination address (DA)	Addressed to me
Timeout [ms]	300
Poll trigger	Not used
<input checked="" type="checkbox"/> Paged protocol	{Not used}
<input type="checkbox"/> Parameters	{}



#### Destination address (DA)

Enter destination address for PDU1 PGN's. This property is enabled when property PGN is in the PDU1 range.

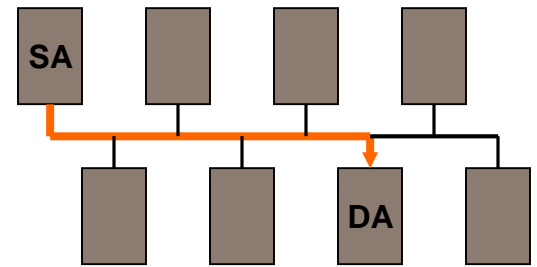
Select *Addressed to me* to receive messages that are either broadcast or addressed to the J1939 module that this channel is assigned to.

Valid range is 0 - 255.

Value types: Integer number, Constant



# JFOUT PDU1 message



- Destination Address = Assigned module

Source address on J1939 module in the system layout

Property Inspector - J1939 module

Property	Value
c>Name	CM0504
Description	
Enabled	Yes
Source address	160
Timeout [ms]	2000

Property Inspector - J1939 frame output channel (JFOUT)

Property	Value
c>Name	Aux I/O status 7
Description	
J1939 source address	Default
Priority	6
PGN	39936
Destination address (DA)	Assigned module
Send method	Continuously
Transmit rate [ms]	Every cycle
Trigger	
Unused bits	Set to 1
<input type="checkbox"/> Parameters	{}



### Destination address (DA)

Enter destination address for PDU1 PGN's. This property is enabled when property PGN is in the PDU1 range.

Select *Assigned module* to send message to the J1939 module that this channel is assigned to.

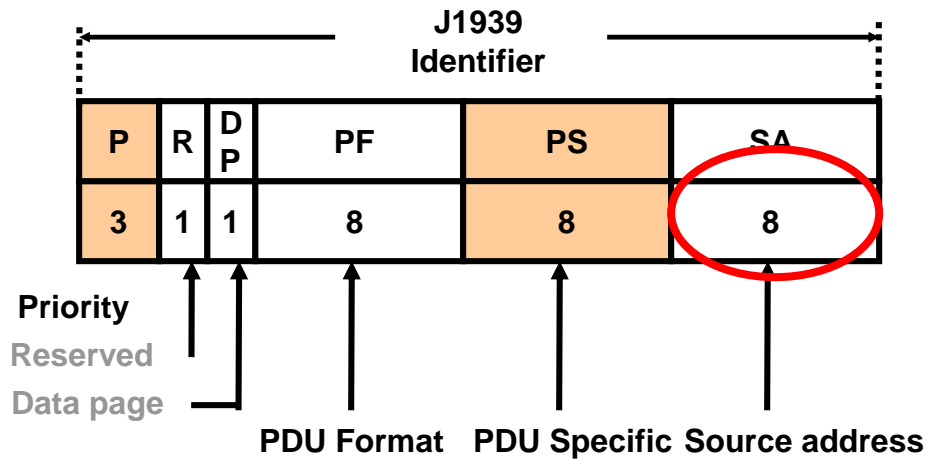
Select *Broadcast* to send message to all J1939 modules that exist on the same CAN bus as the module that this channel is assigned to.

Valid range is 0 - 255.

Value types: Integer number, Constant

# J1939 identifier –Source Address

- SA –Source Address



# Source Address Messages from Engine

The screenshot shows a diagnostic software interface with a 'Modules' section on the left and a 'Property' table on the right. In the 'Modules' section, a purple circle labeled 'Diag' is connected to a grey box labeled 'MD4 MD4-7[0]' with ports A, B, C, and D. Port A is connected to a green circle labeled 'J1939', which is in turn connected to a green box labeled 'Engine J1939[0]' with port A. The 'Engine J1939[0]' module is circled in red. The 'Property' table on the right has the following data:

Property	Value
Name	Engine
Description	Engine source address: 0
Enabled	Yes
Source address	0
Timeout [ms]	Not used

Below the table, there is a section titled 'Source address' with the following text: 'Enter the J1939 source address for this module. Example: A diesel engine is usually address 0. Valid range is 0 - 255.' The 'Source address' property in the table is circled in red, and a red arrow points from the text 'Engine source address: 0' to the value '0' in the table.

# Source Address Messages from IQAN

The screenshot shows a software interface with a network diagram on the left and a property table on the right. The network diagram includes a purple circle labeled 'Diag', a green circle labeled 'J1939', and a white box labeled 'Engine J1939[0]'. A yellow box highlights the 'MD4' module, which is connected to the 'Diag' module. The 'MD4' module has four ports labeled A, B, C, and D. The 'J1939' module has port A connected to the 'MD4' module's port A. The 'Engine J1939[0]' module has port A connected to the 'J1939' module's port A. The property table on the right has the following data:

Property	Value
Name	MD4
Description	
Address	0
Optional	No
RTC enabled	Yes
J1939 source address	39
Terminate CAN-A	Yes
Terminate CAN-B	Yes
Terminate CAN-C	Yes
Terminate CAN-D	Yes
IP address	{Default}

## Common options

- 3: Transmission #1
- 17: Cruise Control Speed-based control
- 33: Body Control
- 39: Management Computer #1

Messages **sent by the IQAN master** module on this bus will be sent with this Source address.

# J1939 PREFERRED ADDRESSES

Address ECU-Module Definition:

- 0 Engine #1
- 1 Engine #2
- 2 Turbocharger
- 3 Transmission #1
- 4 Transmission #2
- 5 Shift Console – Primary
- 6 Shift Console – Secondary
- 7 Power TakeOff - (Main or Rear)
- 8 Axle – Steering
- 9 Axle - Drive #1
- 10 Axle - Drive #2

Address ECU-Module Definition:

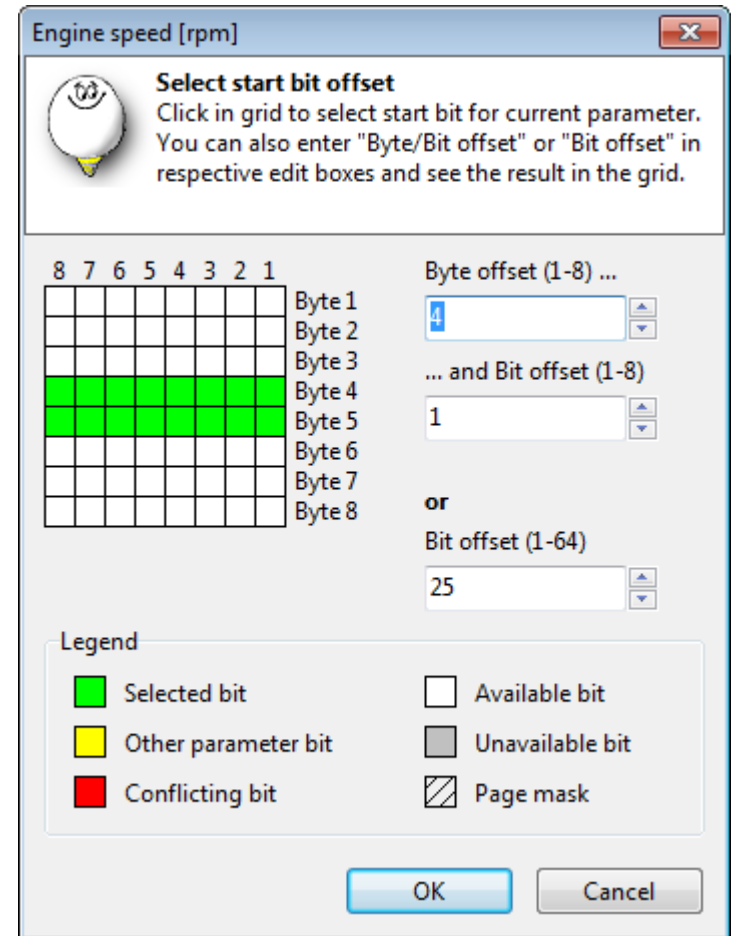
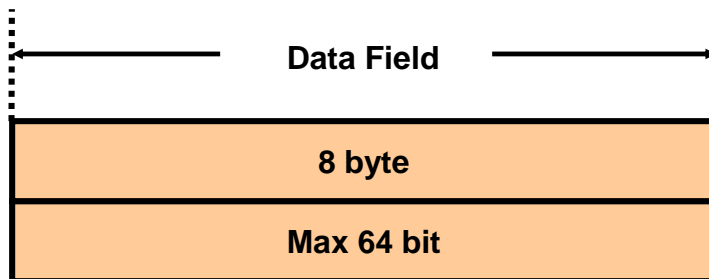
- 11 Brakes - System Controller
- 12 Brakes - Steer Axle
- 13 Brakes - Drive axle #1
- 14 Brakes - Drive Axle #2
- 15 Retarder – Engine Engine Compression Braking
- 16 Retarder – Driveline
- 17 Cruise Control Speed-based control
- 18 Fuel System
- 19 Steering Controller
- 20 Suspension – Steer Axle
- 21 Suspension – Drive Axle #1
- 22 Suspension – Drive Axle #2
- 23 Instrument Cluster
- 24 Trip Recorder
- 25 Passenger-Operator Climate Control
- 26 Electrical Charging System
- 27 Aerodynamic Control
- 28 Vehicle Navigation
- 29 Vehicle Security
- 30 Electrical System
- 31 Starter System
- 32 Tractor-Trailer Bridge #1 Tractor mounted bridge leading to trailer (s)
- 33 Body Controller
- 34 Auxiliary Valve Control
- 35 Hitch Control
- 36 Power Take Off (Front or Secondary)
- 37 Off Vehicle Gateway
- 38 Virtual Terminal (in cab)
- 39 Management Computer #1**  
(Manages vehicle systems, i.e.power train)

Source address

Source address				
P		PF	PS	SA
3		8	8	8

# J1939 Data field

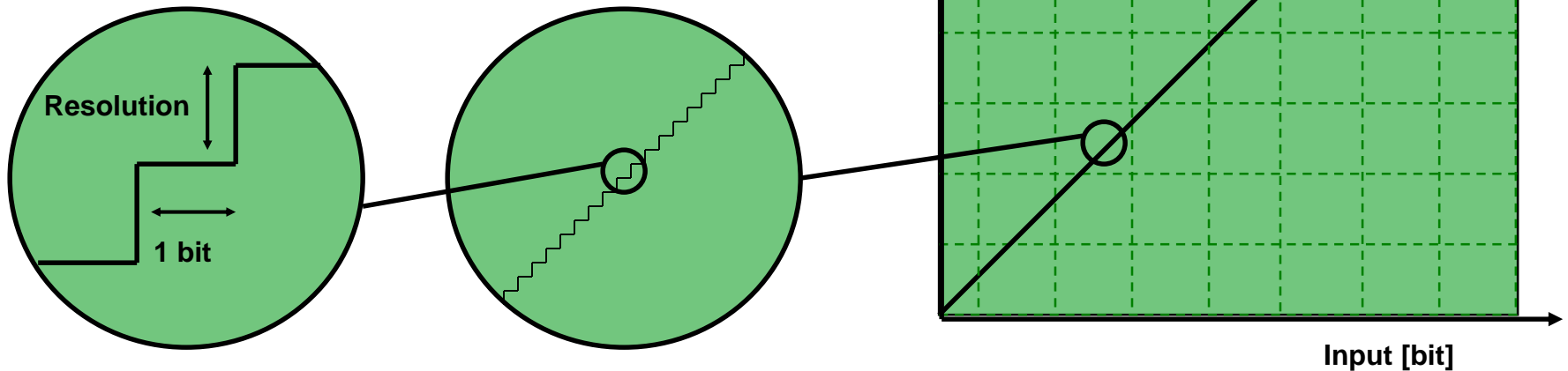
- **Data field:**
  - 8 byte (64 bit) data



# Resolution

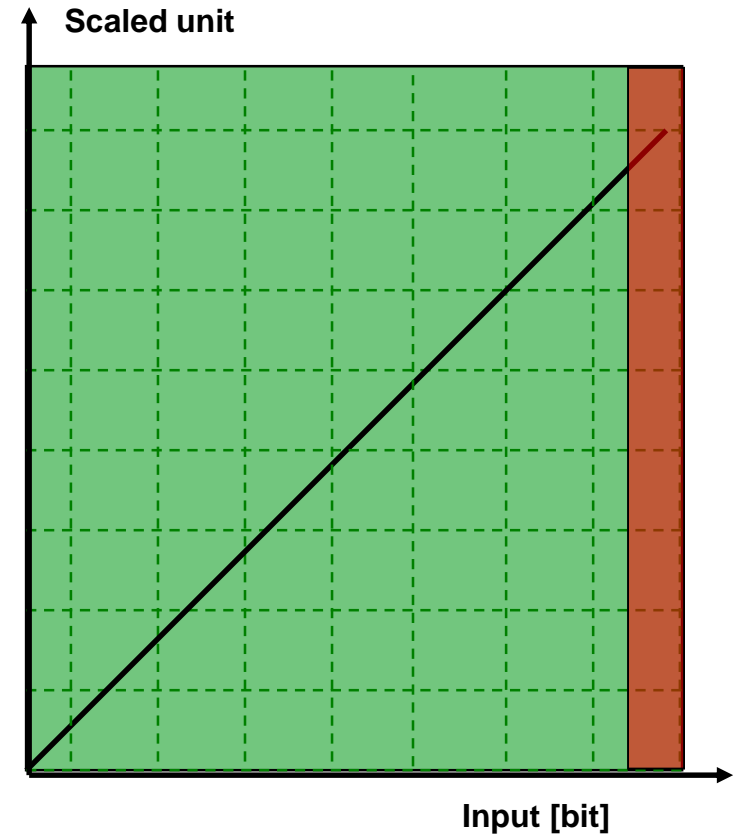
- Resolution

- scaled unit /bit
- 1 byte: 256 steps
- 2 bytes: 65 536 steps
- 4 bytes: 4 294 967 296 steps



# J1939 error detection

- Error detection
  - 2 bit: Error > 1
  - 1 byte: Error > 250
  - 2 byte: Error > 64255





# J1939, Boolean values

- Represented as 2 bits

0	False
1	True
2	J1939 error
3	J1939 not available

# JPIN channel

## J1939 parameter in

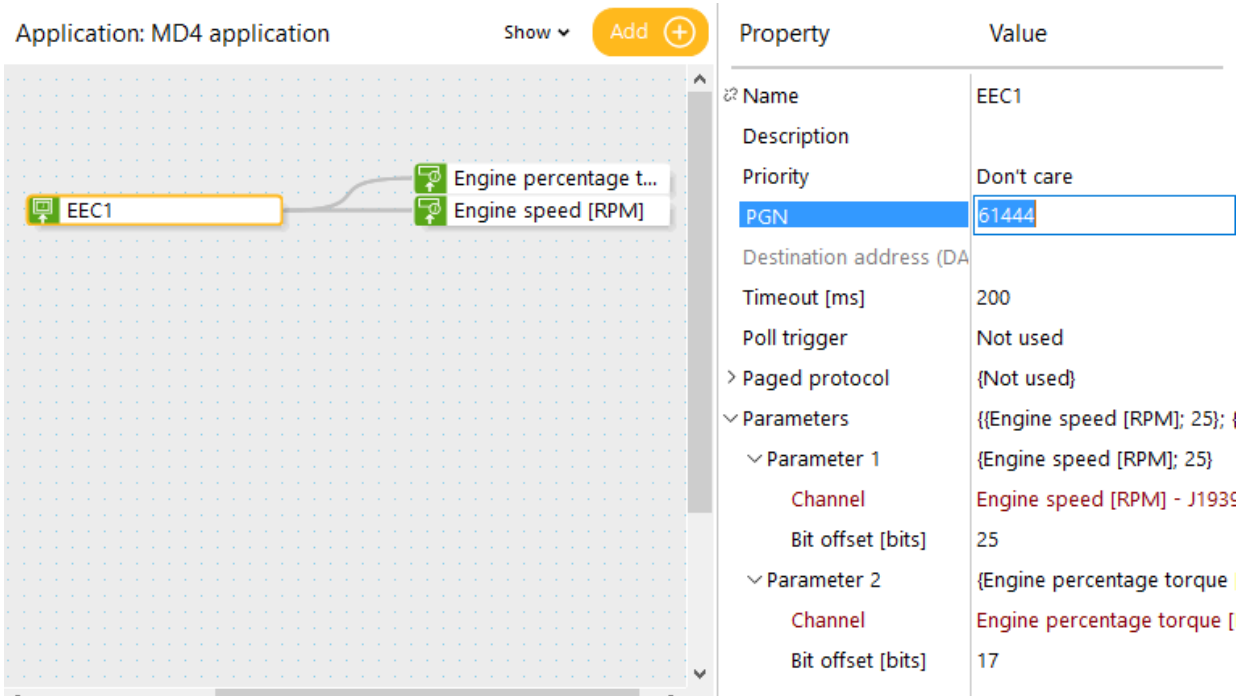
- Properties

- Name
- Unit
- Length
- Resolution [scaled unit /bit]
- Offset [scaled unit]

Property	Value
Name	Engine speed <input type="checkbox"/>
Description	
Unit	RPM
Length [bits]	2 Bytes (= 16 bits)
J1939 Error check	Yes
Resolution [per bit]	0,125
Offset	0
Error value [RPM]	0

# J1939 CAN frame in (JFIN) J1939 parameter in (JPIN)

Application: MD4 application    Show ▾    Add (+)

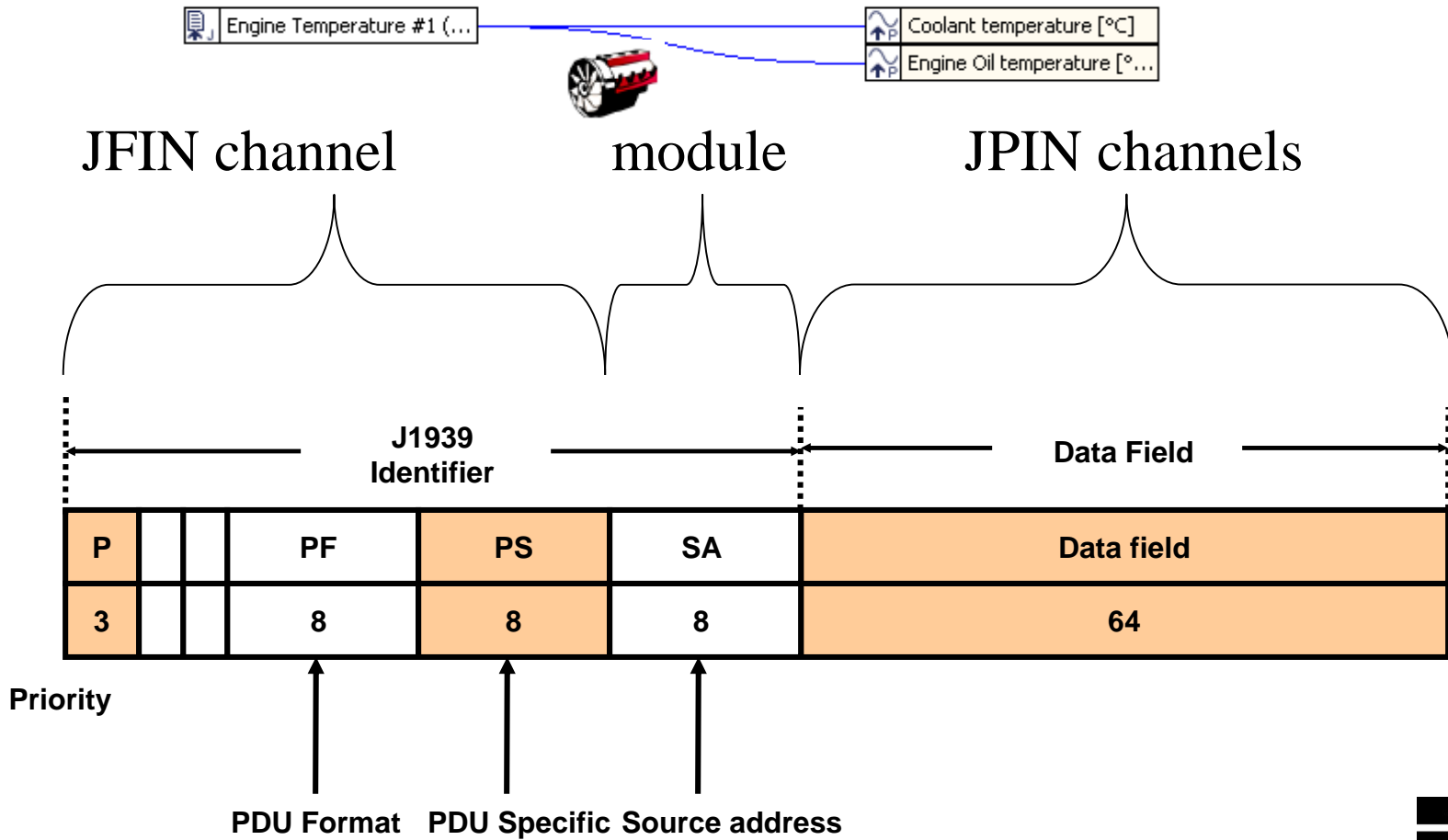


Property	Value
Name	EEC1
Description	
Priority	Don't care
PGN	61444
Destination address (DA)	
Timeout [ms]	200
Poll trigger	Not used
> Paged protocol	{Not used}
Parameters	{{Engine speed [RPM]; 25}; {
Parameter 1	{Engine speed [RPM]; 25}
Channel	Engine speed [RPM] - J1939
Bit offset [bits]	25
Parameter 2	{Engine percentage torque [
Channel	Engine percentage torque [
Bit offset [bits]	17

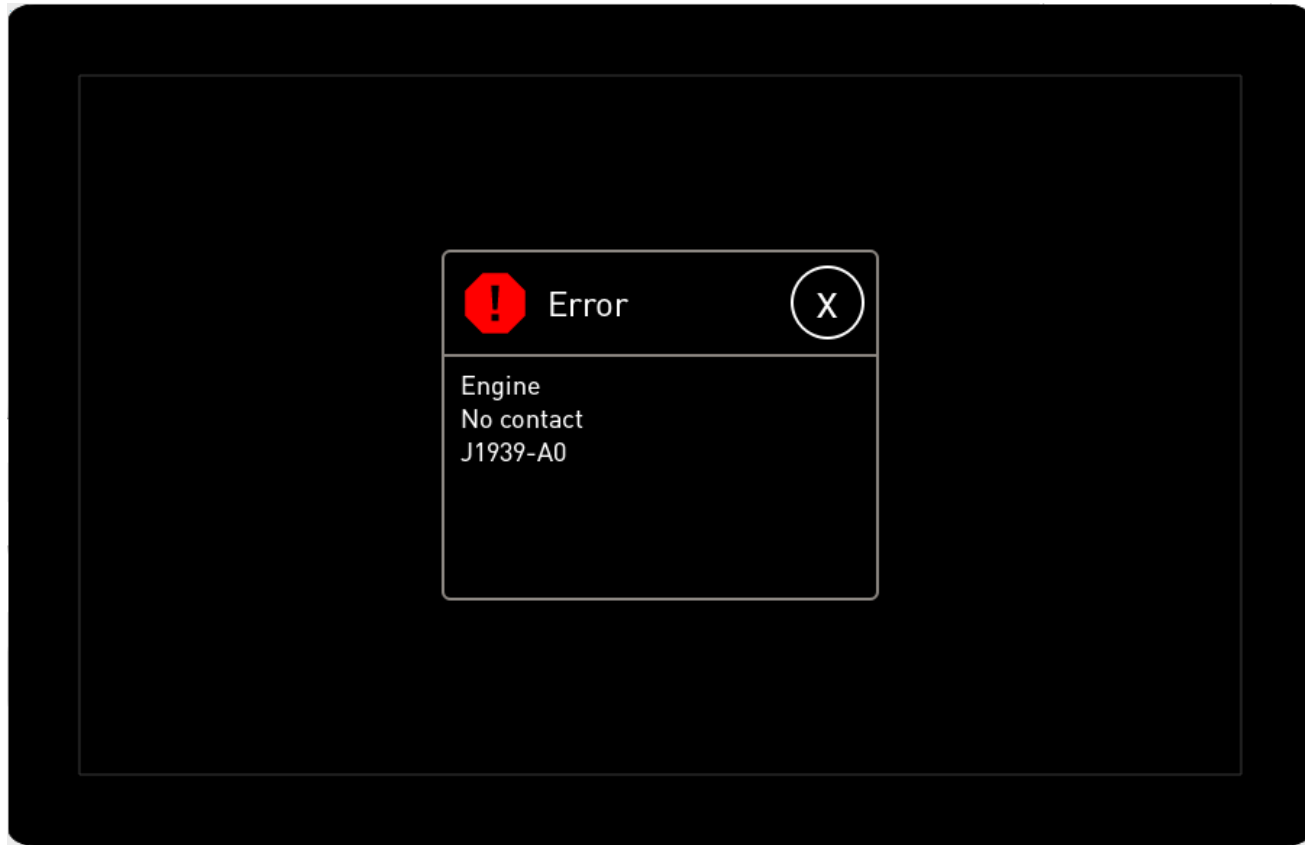
- **Example**

- JFIN:            EEC #1
- Parameter in: Engine speed

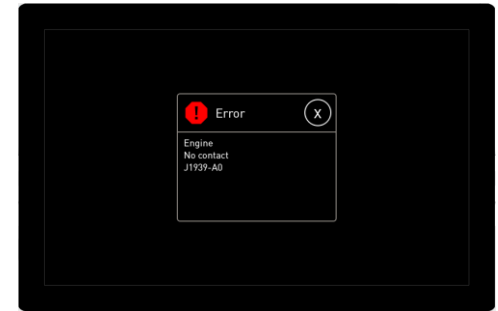
# Summary



# Timeouts



# Timeouts

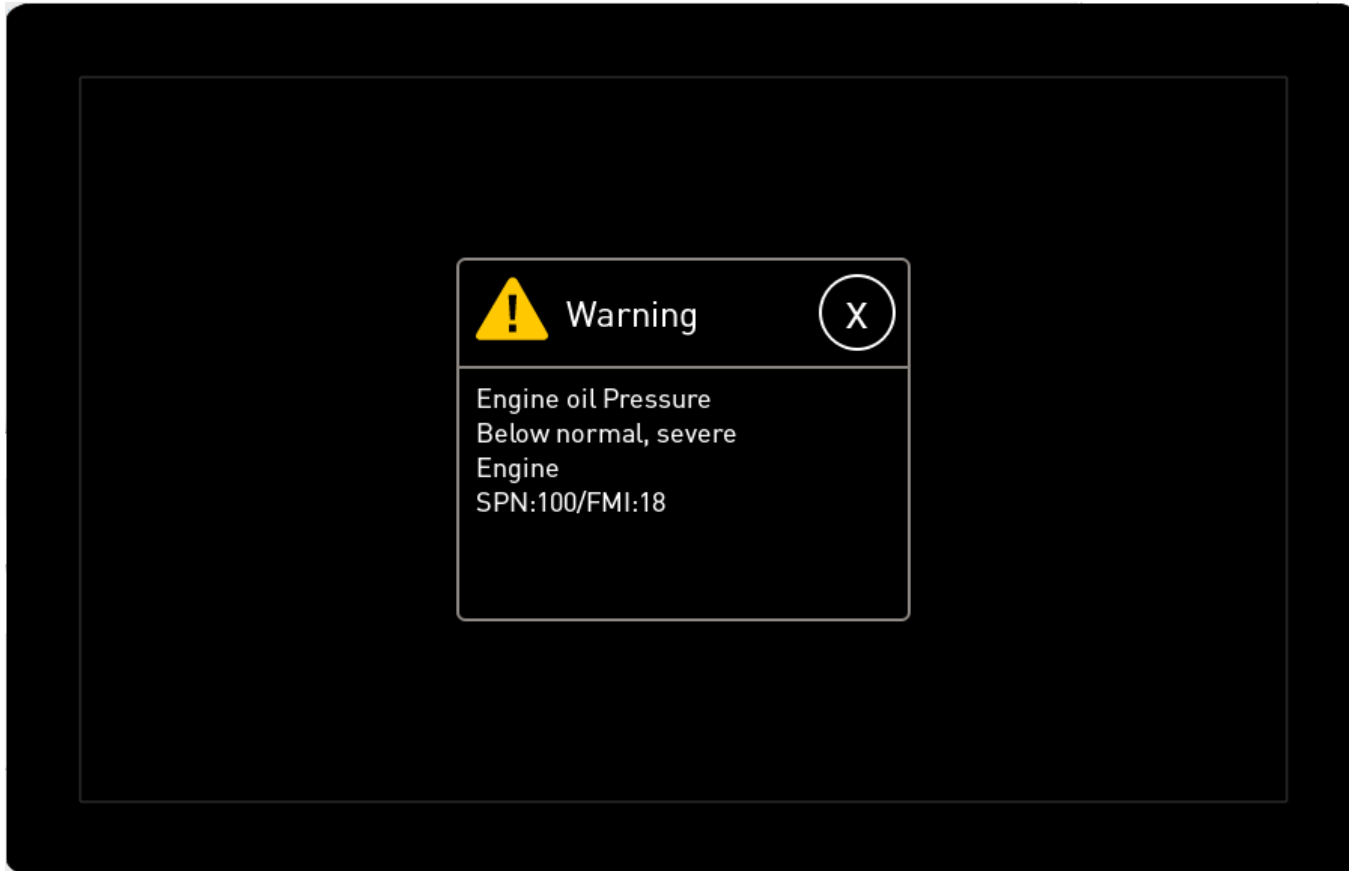


- J1939 module timeout
  - No contact message on screen
  - Sets error value on JPIN parameters



- Individual JFIN timeout
  - Use for shorter timeouts for faster response

# J1939 diagnostics



# DM1

- **DM1-Diagnostic Message**
  - SPN-Suspect Parameter Number
  - FMI-Failure Mode Identifier



# SPN 190

# Engine Speed

Engine Speed / Actual engine speed which is calculated over a minimum crankshaft angle of 720 degrees divided by the number of cylinders.

Data Length:	2 bytes
Resolution:	0.125 rpm/bit gain, 0 rpm offset
Data Range:	0 to 8031.875 rpm
Type:	Measured
Supporting information:	
PGN reference:	61444

# SPN

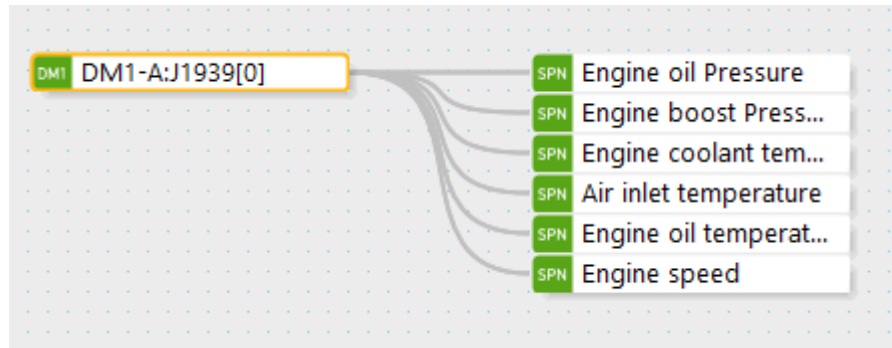
SPN SPN in

## Suspect Parameter Number

Property	Value
Name	Engine oil Pressure
Description	
SPN	100
Dialog priority	Warning
> Failures	<ul style="list-style-type: none"><li>Don't show</li><li>Message</li><li>Information</li><li>Confirmation</li><li>Warning</li><li>Alarm</li><li>Error</li><li>Critical</li></ul>

# DM1

- DM1
  - SPN-Suspect Parameter Number
  - FMI-Failure Mode Identifier



# FMI/SPN

- **Example: Engine oil pressure sensor, voltage below normal. SPN=100, FMI=4**

0: Above normal, most severe

1: Below normal, most severe

2: Erratic or intermittent

3: Voltage below normal

4: Voltage above normal

5: Current ...

	0	1	2	3	4	5
96: Fuel level						
100: Eng. oil pressure					X	
110: Coolant temp						
111: Coolant level						

# Failure Mode Identifier

- **FMI**
  - Between 0 and 31  
(-1 indicates OK in IQAN)
  - Adjustable texts

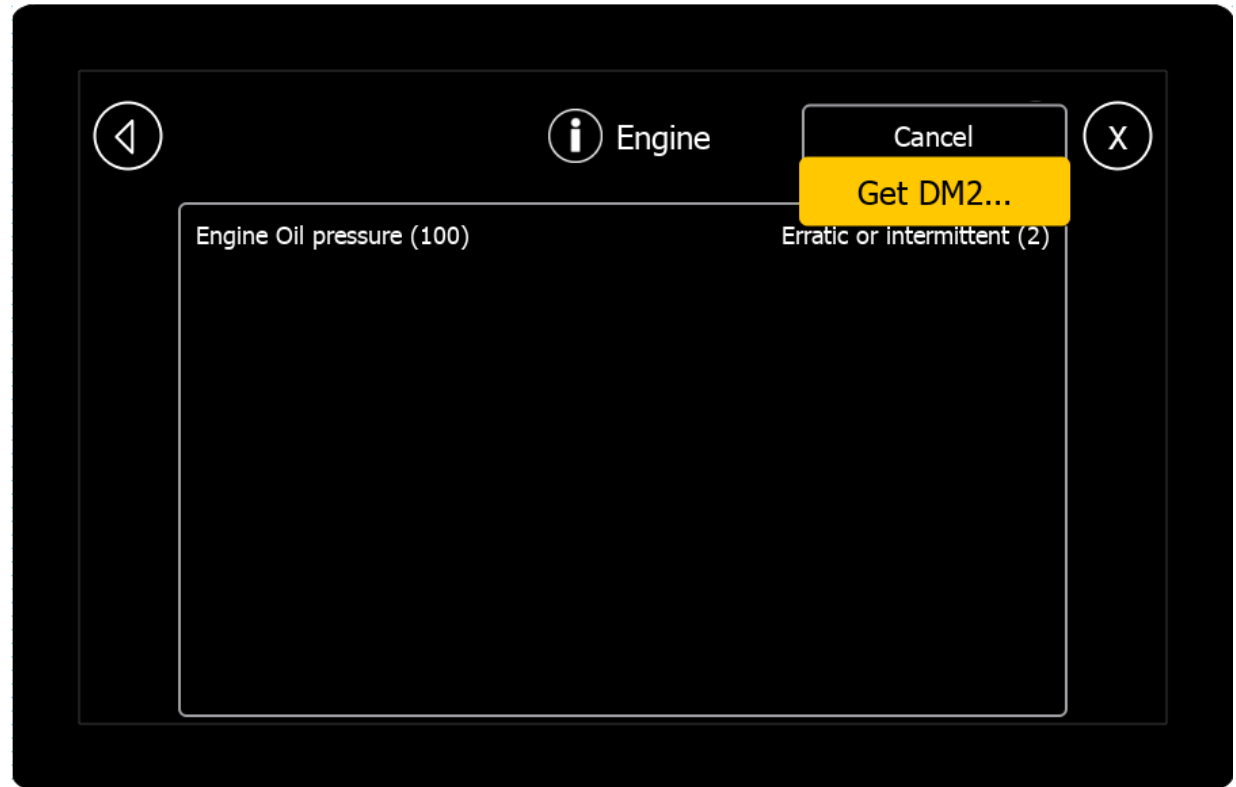
Property	Value
Name	DM1-A:J1939[0]
Description	
SPN conversion method	4
✓ FMI texts	d; Reserved; Not availa
FMI text -1	OK
FMI text 0	Above normal, most severe
FMI text 1	Below normal, most severe
FMI text 2	Erratic or intermittent
FMI text 3	Voltage above normal
FMI text 4	Voltage below normal
FMI text 5	Current below normal
FMI text 6	Current above normal
FMI text 7	Out of adjustment
FMI text 8	Abnormal frequency
FMI text 9	Abnormal update rate
FMI text 10	Abnormal rate of change
FMI text 11	Root cause not known
FMI text 12	Bad component
FMI text 13	Out of calibration
FMI text 14	Special instructions
FMI text 15	Above normal
FMI text 16	Above normal, severe
FMI text 17	Below normal

# DM2

## Read old faults from J1939 module

Property Inspector - DM1 channel (DM1)

Property	Value
c->Name	DM1
Description	
SPN conversion method	4
FMI texts	{OK; Above normal, most severe; Below
Show message	All
Enable DM2 support	True
Parameters	{Engine Oil pressure; Engine Boost Pre
Channel 1	Engine Oil pressure - SPN in channel (
Channel 2	Engine Boost Pressure - SPN in chann
Channel 3	Engine Coolant Temperature - SPN in
Channel 4	Air Inlet Temperature - SPN in channe
Channel 5	Engine Oil Temperature - SPN in char
Channel 6	Engine Speed - SPN in channel (SPN)



# Example file

\Documents\IQAN Files\Solution Library  
J1939 Engine.ids4